Jet Propulsion Laboratory Free-l~lying Magnetometers for Distributed *In-Situ* Multiprobe Measurement of Current Density Filamentation in the Northern Auroral Y.one: Enstrophy Mission

H. Javadi, B. Blaes, M. Boehm †, C. Cruzan, J. Gibbs, W. Goodman *, U. Lieneweg, K. Lynch@, P. Narvaez, D. Perrone, R. Snare#, M. Sue, L. Turoski, K. Leschly, and R. Goldstein

Jet Propulsion Laboratory, 4800 Oak Grove lb., Pasadena, CA 91214
† Lockheed Martin Palo Alto Research Center, Palo Alto, CA
* Applied Physics Systems, Mountain View, CA
# University of California at Los Angeles, Los Angeles, CA
@ University of New Hampshire, Durham, NH

The Enstrophy sounding rocket mission is a collaborative project between the University of New Hampshire, Cornell Universit y, and the Jet Propulsion Laboratory (JPL) to study filamentation phenomena in the northern Auroral zone. The Enstrophy mission will test fly the JPL Free-Flying Magnetometer (FFM) concept. The FFM technology development task has been funded by NASA / J 1'1. to develop miniaturized, low-power, integrated "sensorcrafts". JPL's goal is to design, integrate, test, and deliver four FFMs to be deployed from the sounding rocket, allowing a unique determination of curl-B. This will provide a direct measurement of magnetic-field-aligned current density along the rocket trajectory.

A miniaturized three-axis flux-gate magnetometer will be integrated with 22-bit ADC, four temperature sensors, digital electronics, seven (Li-$SOCl_2$) batteries, two (4^o x 170^o field of view) sun-sensors, a nutation damper, a (fan-shaped beam) laser diode beacon, a (16 MHz) stable Temperature Compensated Crystal Oscillator (TCXO) clock, a data communication subsystem, and an antenna for approximately 15 minutes of operation which consists of three (3) data gathering phases interleaved with bursts of data transfer (approximately 30 seconds each) to Poker Flat's ground station TOTS antennas. FFMs are stowed within two trays onboard the rocket during the rocket launch and will be released simultaneously using the spinning action of the rocket at approximately 300 km alltitude. FFMs will be deployed with spin rate in the range of 4-8 Hz with 2-3 m/sec linear velocity with respect to the rocket. While the rocket is in the launch pad and prior to release of FFMs from the rocket, commands (such as start, test, calibration, and synchronization) are transmitted via a infrared Light Emitting Diode communication to a infrared detector in the FFM. Special attention will be paid to low magnetic signature system design and choice of materials in packaging. Miniaturized flux-gate magnetometers have a range of 1-65536 nT with 0.1% full-scale linearity. The frequency range of interest for magnetic measurement is 10 mHz- 50 Hz. Digital data from the magnetometer's three axes are placed in a 4MB SRAM in data packages formatted together with time tags and frame ID. After a specified time is elapsed, the data is Viterbi encoded and transmitted at a rate of 100 kbps (BPSK). The carrier frequency is in the range of 2200-2300 MHz. The antenna is a single patch on a high dielectric constant substrate covering one end-plate of the "hockey-puck" sized unit. The local clocks aboard FFMs are reset at the start of the mission and stay synchronized within 3 msec during the mission. Position of each FFM with respect to the rocket is calculated by the knowledge of its release velocity providing an accuracy of 1 m over the maximum range of 3 km. Spatial and temporal nature of observants can be separated to within 3 m in space or 3 msec time interval.